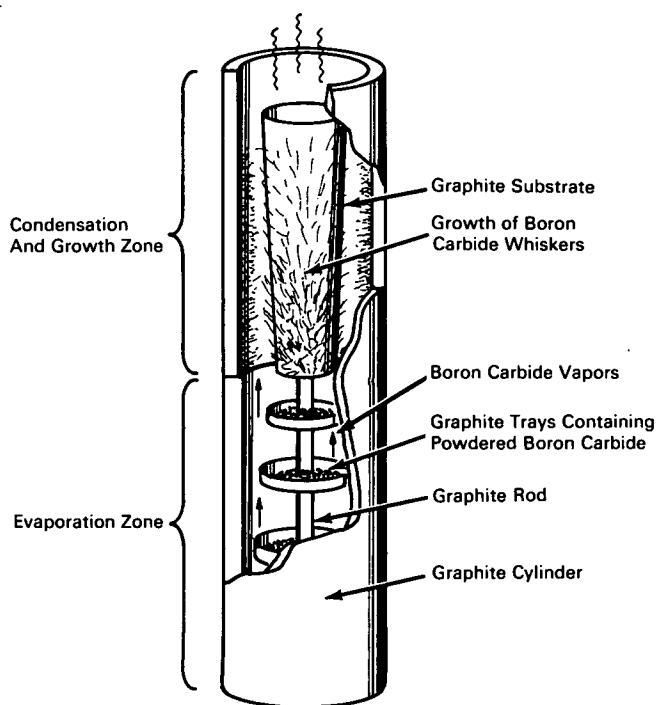


NASA TECH BRIEF



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Boron Carbide Whiskers Produced by Vapor Deposition



The problem: To devise a method for quantity-production of boron carbide (B_4C) whiskers (filamentary crystals) of satisfactory size, form, and orientation. These whiskers possess an excellent combination of properties, including high modulus of elasticity and tensile strength-to-weight ratio at low and elevated temperatures, high melting point, and chemical inertness, which make them highly desirable as a reinforcement component in composite materials that must withstand rigorous environmental conditions.

The solution: The process consists of vaporizing boron carbide powder at approximately $1900^\circ C$ and

condensing the resultant vapors on a substrate maintained at a lower temperature. Specific catalysts added to the boron carbide powder promote the growth rate and size of the whiskers.

How it's done: The boron powder, admixed with a small amount of catalyst (vanadium, niobium, or molybdenum), is placed in a stack of concentric graphite trays of diminishing diameter supported on a central rod of graphite. A conical deposition mandrel or substrate of graphite on which the whiskers are grown is mounted above the uppermost (smallest) tray on the graphite rod. This stack is centered in a hollow

(continued overleaf)

graphite cylinder and the entire assembly is placed in a furnace in which two temperature zones (one zone at approximately 1900°C and the other at approximately 1700°C) are maintained. The entire operation is conducted in argon at a pressure of 50 to 75 microns of mercury. During the controlled heating process, boron carbide vapors from the powder in the trays rise inside the graphite cylinder and condense on the graphite substrate. As condensation proceeds, the whiskers grow on the extended surface of the substrate. Several column assemblies may be processed in a single furnace of sufficiently large size to increase the yield of the whiskers.

Notes:

1. To grow whiskers of optimum size, orientation, and form, it is necessary to control the composition and concentration of the vapor phase, temperature gradients in the evaporation and condensation zones, and the time of operation. Investigations

are being conducted to determine optimum processing parameters.

2. Inquiries concerning this invention may be directed to:

Technology Utilization Officer
NASA Headquarters
Code ATU
Washington, D.C., 20546
Reference: B65-10261

Patent status: NASA encourages the immediate commercial use of this invention. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

Source: Space Sciences Laboratory,
General Electric Company
under contract to
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